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Radical Technological Innovation and Perception: A Non-Physician Practitioners' Perspective

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Abstract: Radical technological innovations, such as chatbots, fundamentally alter many aspects of healthcare organizations. For example, they transform how clinicians care for their patients. Despite the potential benefits, they cannot be integrated into practice without the support of the clinicians whose jobs are affected. While previous research shed important light on physicians' perceptions, little is known on non-physician practitioners view said innovations. This paper reports on a qualitative study, involving 10 non-physician clinicians from Ontario, Canada, conducted to determine the perceptions and cognitions of clinicians regarding radical innovation and their previous experiences with technological change. Results indicate that clinicians as semi-autonomous agents can interpret and act upon their environment with regard to determining how innovations such as chatbots are implemented.

INTRODUCTION

There has been an influx of digital innovations within the healthcare industry that have created opportunities to improve many aspects of healthcare. Despite the availability of these innovations, the important question as to how a technological innovation achieves widespread adoption remains. Many studies of healthcare innovations focus solely on the factors that would be important for a single actor to use the technology, but this approach ignores much of a complex context that characterizes healthcare. One aspect of this context would be the healthcare institutions, which contain many diverse professions, competing interests and other forces that may influence the adoption and use of these technologies. One must consider as well that these technological innovations may bring about a fundamental change to healthcare processes, and not merely consist of an additional task that users must perform. Artificial Intelligence (AI) can be considered one of these technologies. AI seeks to mimic human cognitive functions, enabling physicians to make clinical decisions based on the health information gained from the patient (Jiang, Jiang, Zhi, Dong, et al., 2017). Chatbot agents are one implementation of AI capabilities in an interface that is familiar to patients. Chatbots have been implemented to provide support for independent elderly people (Fadhil, 2018), psychiatric counselling for mental healthcare (Oh, Lee, Ko, & Choi, 2017), and others. These and other technologies have the potential to fundamentally change how healthcare providers and patients manage their relationship and perform their respective activities, within the context of healthcare institutions. Despite this, research on chatbots in healthcare has largely focused on patients. Therefore, this research seeks to address this gap and answer the following question: *What are the cognitions and perceptions of clinicians regarding radical technological innovation in healthcare organizations?* To fulfill this purpose a qualitative study was conducted to determine the influence of institutional and contextual factors affect the clinicians' intent to implement the technology.

LITERATURE REVIEW

Technology in healthcare provides many opportunities for patients, clinicians, and many more actors. Among these are the ability for patients to have health related interactions online, and the sharing of big health data from institution-to-institution broadening the scope of available information (Eysenbach, 2001). Artificial Intelligence (AI) is one of these technologies that is increasingly implemented in healthcare. The purpose of AI is to mimic human cognitive functions, enabling physicians to make clinical decisions based on the health information gained from the patient (Jiang et al., 2017). Chatbots in particular encompass a multitude of AI components, such as machine learning, natural language processing, image and voice processing, in a way that engages with patients in a

familiar manner (AHIMA, 2017). They can help track symptoms (Alescanco et al., 2017) and facilitate adherence to a medical regimen (Marciel et al., 2010) for chronic disease patients, connect with an electronic medical record (Ni et al., 2017), or provide wellness-related education (Crutzen et al., 2011).

Although the potential for chatbots to provide benefits to both patients and healthcare systems are clear, the difficulty arises in adoption and embedding these systems successfully into practice, so that they have sustained benefits. Research has determined that there have been reportedly more failures than successes with regards to technological implementations in the healthcare field; the glaring issue, appearing to be the scale of the technological innovation, the broader the scope of implementation the more daunting the task, which affects the potential to achieve a successful implementation (Berg, 2001). According to previous research, the success of information systems can be largely based on the level of acceptance the healthcare professionals have regarding the technology, thus necessitating the acceptance of the technology by the healthcare professionals in order for the technology to be adopted and implemented successfully (Oroviogioicoechea, Elliott, & Watson, 2008).

A technological innovation is considered radical when the innovation fundamentally alters the work processes, the means of communication, or the work environment as whole (Ringberg et al., 2019). The decision-makers engage in divergent thinking when considering implementing a radical innovation as this form of technological implementation necessitates a fundamental shift from the previous methods (Ringberg et al., 2019). Chatbots are considered a radical technological innovation as it has the ability to alter the means by which patients, and healthcare professionals interact within the healthcare field. The implementation of chatbots and many other healthcare technologies would fundamentally shift the means by which patients are able to receive health related information tailored to their specific health issues. As well, the radical innovation would fundamentally shift the means by which healthcare professionals disseminate information, and are able to collect real time statistics based on the wireless monitoring of their patients.

Research Gaps

This research seeks to address two research gaps. First, despite the potential benefits of chatbots, their adoption and use in healthcare have not been extensively studied. Several focused applications of chatbots have been studied, specifically in the contexts of cystic fibrosis (Marciel, et al., 2010), substance abuse for adolescents (Crutzen et al., 2011) and a few others. This study seeks to add to the literature on chatbot adoption. Second, the existing studies focus on patients (Yu, Beam, & Kohane, 2018) and physicians' perception (Sarwar et al., 2019) of artificial intelligence. For instance, we know that among physicians, AI is generally perceived as a diagnostic tool to facilitate improvements in workflow efficiency and quality assurance in pathology. However, little is known on the perspective of non-physician healthcare practitioners. As healthcare practices involve multiple parties in a more complex context, our extant silence on non-physicians is regrettable. Therefore, it is important to grasp the clinician's perceptions with a consideration of their institutional context if chatbots and other radical technological innovations are to be adopted effectively and widely. Therefore, this research seeks to answer the following question: *What are the cognitions and perceptions of non-physician clinicians regarding radical technological innovation in healthcare organizations?*

MICRO-INSTITUTIONALISM

The theoretical foundation for this research is micro-institutionalism. Institutions are "structured social practices that have a broad spatial and temporal extension: that are structured over long periods of time, and which are followed or acknowledged by the majority of members in society" (Giddens, 1981). Institutional theory has recently begun a fundamental shift from a solely macro-level approach toward a multilevel paradigm explicitly incorporating individuals and on the ground dynamics (Schilke, 2018; Bechky, 2011; Fine & Hallett, 2014; Thornton et al., 2012).

For this research, we turn to micro-institutionalism for building our analytical framework on non-physician clinicians' perceptions. To begin, a micro-institution is considered to be an organization that has shared values and vested interests, and is comprised of formal structures and procedures developed to assist in the achievement of organizational objectives (Bhattacharya, & Elsbach, 2002). Micro-institutionalism focuses on individual agents as the basic unit of analysis, in some instances referred to as actors interchangeably (Schilke, 2018). Micro-

institutionalism seeks to extend the literature on institutionalism and acknowledge the interplay of decision-makers in the environment and their cognition. For institutional inquiry to be extended it is crucial to focus on how local conditions shape the way decision-makers perceive, interpret, and act within the environment (Schilke, 2018; Bechky, 2011; Creed et al., 2014; Hallett, 2010; Powell & Bromley, 2013).

Micro-institutionalism provides an opportunity to explain variations in resistance to adopting organizational practices (Schilke, 2018), thus illuminating the role decision-makers' cognitions play in organizational practice adoption. Therefore, conveying the organizational decision-makers are the institutional mediators as they mediate the interface between the organizational environment and organizational action (Barley, 2008); from this conceptualization it is apparent the need to understand the cognitive processes of the mediators as their actions are reflections of the effects of the external institutions (Barley, 2008). It is pertinent to identify the local contexts of the environment and explore the individual actors' cognitive processes in order to understand the enabling conditions of actorhood (Schilke, 2018). A main facet for micro-level inquiry is cognition, specifying two cognitive mechanisms—certainties, and attention, which explain decision-makers' variation in resistance to institutional pressures (Schilke, 2018).

METHODOLOGY

The research design for the study encompasses primary data collection and analysis of the data. A qualitative research design is necessary as the facets being explored are emergent. Clinicians in Ontario, Canada, were sought individually through an online advertisement. The advertisement contained the qualifier dictating only clinicians who have encountered technological change in the work place are eligible to participate in the research; this ensured that the participants were able to provide relevant information for the study. The clinicians as individuals are the unit of analysis.

The interview guide was developed in accordance with facets of micro-institutionalism, and radical technological innovation. The key themes for this are: *previous technological experiences*, *perceptions of chatbots*, and *potential resistance and issues*. The questions were derived from the literature and the theory to gain insights regarding the clinicians' experiences and perceptions. To ensure that the participants understood chatbot technology, the interview process commenced with two videos to debrief the participants regarding chatbot and its capabilities.

After the interviews were completed, the audio files were transcribed by the researcher, and uploaded to nVivo 12 for thematic analysis. Data was analyzed using a thematic analysis (Braun et al., 2018) approach, involving six phases: 1) familiarization with the data, 2) creating a set of initial codes, 3) identifying the themes, 4) reviewing the themes, 5) naming and defining the themes, and 6) developing the final report (Braun, et al., 2018). Lakehead University Research Ethics Board has provided ethics clearance to this protocol.

KEY FINDINGS

Data collection took place between May and June 2019. Interviews took place in person, and over the phone. The researcher found that 10 interviews were validated, as saturation point was reached purporting that newer participants were not contributing additional knowledge to the results (Lee, 1999). All participants explicitly stated that they consented to having the interview audio recorded; as well consent forms were signed. There was no personally identifiable information collected to protect the anonymity of the participants. The semi-structured interviews were conducted with a Clinical Nurse Manager, Registered Nurses, Medical Students, and a Registered Practical Nurse, with a female representation rate of 90%. The primary professions being represented are registered nurses with 60% representation rate, and medical residents with 20% representation rate. Table 1 (below) summarizes this information.

Table 1: Description of the Participants

Profession	Age	Gender
Registered Nurse	53	Female
Registered Nurse	52	Female
Medical Student	27	Female
Clinical Nurse Manager	34	Female
Registered Nurse	25	Female
Registered Nurse	22	Female
Registered Practical Nurse	29	Female
Medical Student	24	Male
Registered Nurse	24	Female
Registered Nurse	54	Female

Analysis of the interviews yielded 4 overarching themes related to the impact of technology, local conditions, resistance, and implementing chatbots. A concise version of the findings is presented here, and an expanded version will be presented at the conference and made available on request.

Impacts of Technology

The benefits of technological innovation range from enhanced organizational work flow to improved patient outcomes. The organizational processes have been improved, as clinicians are now able to more efficiently dictate patient reports and review empirical information. Furthermore, technology provides additional accountability, as uploaded information can be time stamped:

“And there is always proof that things were sent and received versus just getting a piece of paper where there’s not actually a time stamp. So online it has exactly what time it came in so that we knew a report was late” (Interviewee 5).

Technology requires accountability from the patients as well, much like an additional technology for the Telehomecare program:

“Required patients to every morning or however many times a day they are instructed to get on their scale, take their blood pressure through the electronic blood pressure cuff, and then those results are sent to the telehome nurse which was an advantage as a lot of people like the patients in the community, you know you can teach them so much but whether they are doing it or not like you have no idea this way you are getting the actual numbers because everything is hooked up to that iPad which automatically transfers to the nurses” (Interviewee 5).

The interviewees communicated the pitfalls of current technology, as well as mentioned the work processes that would benefit from technology. A detriment of technology mentioned was an over reliance on the information at hand:

“A main drawback is that we need to make sure that we are not just relying on those electronic medical records. For example we had a lady going in for gastric bypass surgery. [...] The surgeon looked at the electronic record and thought everything was fine, anaesthetists looked over the record everything was fine. I looked over the record and this is online and everything looked fine. So when I saw the patient I’m flipping through her chart and I find a tucked in sheet of paper for a sleep apnoea clinic [...] so she has a statistically significant increased risk” (Interviewee 1).

It became apparent that for widespread changes to the technology the majority of clinicians encountered similar training experiences. Training sessions and support were important:

“We had courses and different sessions that the technology team would introduce the technology, and that was pretty good, they took the time with us” (Interviewee 9).

“With the Meditech system there is the IT team that we can call at anytime that helps us through issues” (Interviewee 4).

Local Conditions

It is apparent that local conditions shape the way these agents as decision-makers act within their environment. The local conditions vary from organization to organization as the work processes and the organizational divisions are unique. For instance, in a remote community they may experience variations in methods of care:

“We do it currently in the ICU we were having issues we weren’t able to, as we are a small rural hospital, we didn’t have arterial line monitoring. So the nurses like we talked to our manager and said that we should probably really get that since it’s an ICU, and we were able to convince them to bring it in” (Interviewee 6).

A couple of clinicians expressed that they felt that they did not have the opportunity to act on behalf of themselves to promote technological advances nor were presented with opportunities to voice their concerns regarding issues with their work processes:

“No, not really, it’s kind of just more like organizationally driven. It’s not driven by us, I would say, it’s unfortunate we don’t get our opinions asked on many things” (Interviewee 4).

While, other organizations encourage open interdivisional communication by providing specific communicative tools to the staff:

“So at least specifically on our floor they’ve just started, we’re one of the pilot projects and it’s a whiteboard communication tool on a daily basis that we have to do and it’s to say okay what’s working what’s not working. How can we improve it. We’re one of the pilot floors and management is behind it. Right now we’re getting things done and through quickly. Now once everybody’s on board and management is now going to be a little bit more scarce about supporting things but that would be one of the platforms that we could bring it forward to and say hey you know what. [...] This is an idea we can put it forward and at any point we can send an email to our CEO of the hospital” (Interviewee 10).

Resistance

Resistance with regards to technological innovations within the micro-institutionalism scope were explored based on previous experiences with technological implementations. To begin the perceptions of clinicians who experienced no resistance in their healthcare establishments will be reviewed:

“If there is a need more physicians are willing to pick things up or they’ll at least try and see is this easier, does this make my practice easier” (Interviewee 1).

While, another clinician explained the resistance to be a fear associated with altering the work processes to be more technologically advanced:

“Everybody was scared to go from writing in a paper chart to go to using a computer” (Interviewee 9).

To combat this resistance the organizations generally remedied the matters with similar methods:

“A lot of the senior nurses were given additional time” (Interviewee 3).

While another clinician mentioned that:

“The educators kept reinforcing and educating on how to use it, and how it is a good thing for us” (Interviewee 5).

The repetition aids in the reinforcement of the information allowing for more opportunities for the clinicians to learn the components of the new technologies:

“The older nurses watched the videos a few more times and paid more attention” (Interviewee 6).

Implementing a Chatbot

Affirming that a large portion of patients have access to a smartphone device that would be capable of accessing chatbots. Focussing on accessibility there is a need for access to relevant health information as there may be a lack of access to routine healthcare in some instances. Many applications exist, such as health coaching, treatment adherence, education. Chatbots have potential to assist a broad range of illnesses by helping patients to track their symptoms and issues and providing them with relevant medical advice:

“The ones (patients) with hypertension just to be able to monitor that much like the fellow from the video, they’re having the remote blood pressure and they were able to see that. [...] But I could certainly see it that the patients would be better managed at home before they came into have surgery and then to be followed after” (Interviewee 10).

Potential exists to divert unnecessary trips to the emergency department:

“I think some of the advantages would be like lots of people when they come in and they're like newly diagnosed with stuff and then they don't really have any resources in the community and they end up going to emerge a lot for things like that and that's like a big burden on healthcare people going to emerge because they like don't know what meds they should have taken and stuff like that, and they don't have a family doctor” (Interviewee 4).

The optimal implementation strategy may differ from organization to organization based on the environment's work processes, and dispersion of resources. The clinicians shared their personal cognitions regarding potential implementation strategies. It may be ideal for certain subsets of the patient population to have the clinician further elaborate on the pamphlet, and in that scenario it may be best executed in a family medical practice where there are allotted times for each patient. An opportunity akin to the previously mentioned pilot projects a clinician recommended to:

“Pick one group at a time to do it with a common condition and I would probably communicate the information to patients as they wait for appointments, sometimes there's information in the waiting rooms and try to pitch it that way. So that sounds like an option but it can cause you to keep more organized with their health information..... if it's done to a limited extent and might focus more on mental health care. But if more of that if it also had that connection to linked to existing telehealth networks so that that is the same way they also talk to their doctor so that the technology is associated with. The medical professionals communication as well if it's all happening in one place and it doesn't seem like two systems going at once” (Interviewee 7).

The healthcare professionals may be more resistant if they are uncomfortable using the technology themselves, or advocating the technology to patients. Therefore, it would be important to educate the healthcare professionals to ensure that they are comfortable promoting the tool, and are able to facilitate the provisioning of the app. Another prominent focus would be on selecting the appropriate level of healthcare professional that would be responsible for initiating the conversation with the patients if the advocacy were to be one-on-one as there are levels of healthcare professionals that lack the time necessary to educate their patients on the benefits of chatbots itself.

Another potential issue is users become embedded in their ways and would potentially be uncomfortable using the technology or would be uncertain as to how secure their information would be. Therefore, from the patient perspective there may be some resistance as people are more likely to resist a radical innovation if it disrupts their embedded approaches to life in this case their healthcare.:

“There are a lot of resistive people like when you get used to something for so many years you don't want to change obviously I think change for some people is scary (Interviewee 5).

“We have a lot of the older population who don't have cell phones it's not really a great technology for them” (Interviewee 3).

DISCUSSION

This research seeks to explore the cognitions and perceptions of clinicians regarding radical technological innovation in healthcare organizations. This research employed a micro-institutional lens focussing on the conditions under which actors perceive technology. This research sheds light on the enduring agency debate-questioning whether the clinicians are merely institutional carriers or active agents who perceive, interpret, and act upon their environment (Schilke, 2018). The research determined that indeed in most instances clinicians were actively participating within their environments, advocating for changes, and successfully changing their local conditions. The clinicians' perceptions of radical technological implementation varied based on their previous technological experiences and their personal preferences, and espoused a need for such a technology to be instituted into healthcare organizations. The participants provided insights as to how to optimally implement the tool, concerns regarding resistance, potential problems and outcomes. In a couple of instances, the clinicians considered themselves mere institutional carriers succumbing to the environmental pressures they considered to be administration's guiding policies. Therefore there is evidence that supports the agency debate, proving that agents are able to interpret and act upon their environment if the local conditions are conducive to such actions.

The theoretical contributions provide the potential to expand upon the micro-institutionalism framework. Information Systems research is generally conducted with the Unified Theory of Acceptance and Use of Technology (eg. Kijasanayotin, Pannarunothai, & Speedie, 2009), and the Technology Acceptance Model (eg. Yarbrough, & Smith, 2007); this research sought to be transformational, reticulating radical innovation with micro-institutionalism to discover whether different facets of micro-institutionalism may affect the clinicians' perceptions of radical technological innovations. As posited by Schilke (2018), there are limited studies focussing on decision-makers' experiences and reactions to environmental pressures. This research provides an extension to the theoretical foundations as the majority of clinicians that were interviewed communicated that they were able to act as agents within their organizational contexts, and were able to advocate for change. The majority of the clinicians explained their personal experiences with technological innovations in the workplace, communicating the environmental pressures and the local conditions that were present, which triggered in most cases the resistance from other clinicians in those environments. These findings generally indicate the viability of this new approach for information systems research in healthcare.

The managerial implications associated with this research are as follows. The clinicians have varying perceptions of their abilities to act as agents within their organization, this signifies the differences in organizational policies. A managerial consideration would be to encourage interdivisional transparency to ensure that clinicians have the opportunity to participate in organizational decision-making. The clinicians are the frontline employees that work directly with the patients that would be using chatbots; therefore, they are the optimal source of information when it comes to the applicability and viability of the technology for their patients. As well, their perceptions regarding the optimal implementation strategy are invaluable as they are able to gauge the optimal form that will translate to the best reception of the technology from the patients as well as the other medical staff affected. If clinicians are involved in the decision-making process they are less likely to be resistant to new policies and procedures.

LIMITATIONS

Although this is a small scale study, it has several other limitations. First, the study would have been more effective if the clinicians had the opportunity to engage in an interactive demonstration of the system to gain a better understanding of the capabilities of chatbots. Therefore, this study used chatbots as a reference technology for ideation purposes only, which is not a very robust approach. An additional limitation was the access to clinicians as the representation of nurses is exorbitant in comparison to other healthcare related positions. It would have been beneficial to gain insights from primary care physicians that would be able to advocate for chatbots and their implementation. As well, the opinions of those interviewed may be biased based on their past experiences with

technology; therefore, their perceptions may be considered biased. Regarding the data analysis, reliability could be improved with interrater reliability measures, which would involve another researcher confirming the themes through a parallel coding process. Future research therefore could focus on more rigorous data analysis, ensuring a wider representation of participants, or improving the focal artifact.

CONCLUSION

The purpose of this research is to determine the cognitions and perceptions of clinicians regarding radical technological innovation. A qualitative research design was employed, involving 10 Ontario clinicians. Overall, the results of this study are generalizable to other healthcare establishments as the contexts and experiences are generally similar throughout the healthcare organizations represented. The perceptions and cognitions gathered are reflective of the research question and present the experiences of clinicians, which shape their perceptions of the viability of chatbots. Future directions for research include the integration of chatbots into practice, and the analysis of the effects the implementation has within the micro-institution.

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